XI. *What the larva of* Lycaena arion *does during its last instar.* By T. A. Chapman, M.D., F.Z.S.

[Read June 2nd, 1915.]

Plates XXXVIII—XLVI.

For many years the life-history of *Lycaena arion* has been a puzzle, and has much interested and exercised those of us who find the habits of butterflies, and especially of British butterflies in their earlier stages, to present absorbing biological matter worthy of our best attention.

I am absolved from traversing the whole ground, *ab initio*, by the valuable résumé of all that was known up to last year, and references to where the recorded facts may be found, that was given us by the Rev. Geo. Wheeler in Tutt's "British Lepidoptera," vol. xi. p. 331 *et seq.*

It may be desirable, however, so far to recapitulate as may make it clear in what the puzzle and mystery consisted.

The majority of European Blue butterflies hibernate as larvae in their third instar, having in all five instars. Others hibernate as full-grown and full-fed larvae; others as pupae, and some as eggs. Each of these different habits of, or rather stages for, hibernation is adopted by more than one species.

L. arion differs from all these, and agrees with no other species in its method of passing the winter.

It is not, I believe, alone in having only four larval instars, but to have five is, one may say, the rule in these butterflies.

Living on thyme, chiefly the flowers, it at length reaches the fourth, which is its last, instar some time in or about August, and then goes into hibernation. When it does so, it is so small that until Mr. Frohawk (Entom., vol. xxxix. p. 145) showed that it was still in the same instar when full grown in the spring, one could not avoid supposing that it would have at least one more moult in the spring, and that probably one had made some error in

taking it to be in the fourth instar, and that it must be in the normal hibernating instar, the third adopted by so many other species.

Mr. Frohawk's discovery solved a most remarkable problem, that our previous ignorance practically prevented our realising as existing, viz. How many more instars had the larva when going into hibernation to pass through to become full grown? and the startling answer was, None; it was already in its last instar.

It further compelled us to regard as even more difficult and insistent, the question of how this minute larva, one-eighth of an inch long, grew to its mature dimensions of well over half an inch long and correspondingly thick; in fact, a larva suitable to produce a butterfly as large as *L. arion*.

Did it feed up in autumn, in winter or in spring, or in two or all of these seasons? What was its food?

That it was somehow associated with ants seemed the most acceptable basis for a hypothesis, but still there was something to be said in favour of a vegetable diet. These questions have been discussed by various people in various journals, etc., at considerable length, with the object of thinking out the best way of investigating the problem.

It would not be profitable to discuss in detail the various ideas suggested, since it happens that by a combination of perseverance, and good luck almost comparable with Mr. Frohawk's, I am able to give, not by any means the whole history, but certainly its chief fact and keynote.

On May 14, 1915, on pulling up plants over a nest of *Myrmica scabrinodis* var. *sabuleti* and disturbing the soil at a point close to overhanging heather, etc., a larva of *L. arion* was found; it seemed to be amongst loose earth that the ants had worked over, and if not actually in the ants' nest was within less than an inch of ground actually occupied by the ants.

Unfortunately in the rough process necessary in disturbing plants and soil the larva suffered an injury.

Its length was 11·0 mm. and thickness about 3·0 mm. Its colour a pale earthy flesh-colour, no trace of green anywhere, and the impression it gave was, that it must be a concealed feeder. Mr. Frohawk, as well as I, considered that it was by no means full grown. There were visible some dark contents of the posterior extremity of the alimentary canal, shining through the ventral surface,

elsewhere the larva was too opaque to show whether there was anything of food material in its interior.

The larva was found near the surface, but precisely where in relation to the ants was not ascertained, the earth being broken up before the larva was seen; but it was certainly not in any permanent tunnel or chamber of the ants' nest, but more probably amongst the looser surface material, brought up by the ants and not yet consolidated, and amongst which, in weakly constructed chambers, the ants dispose of their larvae temporarily on fine warm days.

The ant with which this larva was associated was *Myrmica scabrinodis* var. *sabuleti*, for which name I am indebted to Mr. Donisthorpe, who gives me, also, the following names as those of the ants I sent him of species which were more or less frequent or common in the locality. *Donisthorpea* (*Lasius*) *aliena*, *D. flava*, *Tetramorium caespitum* and *Myrmica scabrinodis*. Whether *L. arion* larva occurs with some or all of these also, remains to be seen. *D. flava* has always been supposed to be its host, if it had an ant host, and this is very probably correct, though the grounds for the belief are that the thyme on which the butterflies lay is often that growing on the hills of *D. flava*, and that the larvae and pupae found by Mr. Frohawk were apparently close to or on such a hillock. Nevertheless, these ants are so numerous and their nests so close to each other and almost, one might say, mixed together, that, unless found actually living with the ants, and not merely on or near their nests, one cannot feel at all sure whether their supposed host is really one. On the other hand, *D. flava* makes chambers and galleries, that look very suitable for *L. arion* to inhabit, more extensive, definite and formal than any of the other ants noticed, and yet I and others have dug up and closely examined dozens of nests of *D. flava*, without meeting with any larva of *L. arion* in the actual nest.

The hope of discovering what the larva would eat was unavailing in view of the injury to the larva; there remained, however, the possibility of learning what it had eaten by examining the contents of the alimentary canal. This, fortunately, proved to be a very satisfactory line of investigation, and enabled its recent history, as regards its food material, to be easily determined.

The dark mass seen through the lower surface was the

posterior portion of the gut full of a dark material. It measured 3·0 mm. in length and over 0·5 mm. in thickness. It was rather hard and solid and so remains, as I have not broken it up, but mounted in Farrant's medium its structure is fairly evident. Further forwards in the gut were also portions of contents. These were soft and easily pressed flat on a slide.

The posterior portion of the dark mass is rather shorter and more slender than the forward portion. It presents a quantity of granular material in layers of darker and lighter appearance. It might, though I hardly expect it, yield some structural material from which some information would result were it broken up; for the present, however, I have not done so. The forward portion seems to consist of a mass of minute hairs, of fairly uniform size and structure.

The less dense material found further forwards in the gut presents a number of identical hairs, but also some small triangular chitinous bodies very like mandibles of some insect.

Mr. Donisthorpe having told me that the ant with which I found the larva was *Myrmica scabrinodis* var. *subuleti*, brought to my recollection that last year I had examined and mounted specimens of the larva of *Myrmica scabrinodis*. These came in, now, most usefully, and, to make a long story short, a comparison of the larval skin of *Myrmica scabrinodis*, and of the contents of the alimentary canal of my example of the larva of *L. arion*, showed that the hairs in the *arion* agreed precisely with those of the full-grown larva of *M. scabrinodis*, and that the chitinous triangles agreed exactly with the mandibles of the same larva.

Nothing of a vegetable character was found amongst these contents, and it could not be doubted that the *L. arion* larva had eaten many larvae of *M. scabrinodis* and nothing else for a long time.

The dark mass of *dejecta* in the lower gut suggests several questions. First, perhaps, it seems highly probable that the larva of *L. arion* in its last instar behaves as do the larvae of many bees and wasps, various parasites, such as *Meloecus* and other insects, that live on material that is practically all digestible, and contains very little effete material; that is, it does not, until it has completed its growth, evacuate any of the contents of the gut, but allows

all the undigested material and effete matters to accumulate in the rectum during the whole period of growth, to be ejected when the period for pupation approaches. In the case of some ichneumons it is, if I recollect aright, voided by the imago itself.

This hypothesis is in itself a very remarkable one as applicable to the larva of a butterfly, but it seems difficult in any other way to account for the mass of hairs of *scabrinodis* larvae which represent, obviously, a number of individuals, that must have taken a considerable time in consumption, very much beyond that, that butterfly larvae usually pass between each act of defecation. The mass also occupies its position in a way very unlike material passed along the canal in the ordinary regular manner.

If we adopt this hypothesis, then the division of this mass into two portions raises further questions.

The lower and therefore earlier portion gives no indication of what food it represents, the other later portion represents many larvae of *M. scabrinodis*, all apparently in their last instar.

Does the first portion represent some different diet? it certainly does not represent full-grown larvae of the ant. Does it result from the earlier food being *ova* or young larvae of the ant that were more thoroughly digestible, and so left no recognisable detritus? Was the earlier diet a vegetable one, as some of Mr. Frohawk's observations suggest? Or is some other explanation available? as to which one might speculate, but not very profitably, on several.

As this larva affords me a skin at a period when it is not full grown but still not very far from it, it may be worth while to compare it with the little larva that disappears in the autumn, as the material for doing this which I used in assisting Mr. Wheeler's history of the species, though perfectly satisfactory and conclusive to myself and probably to most other people, did not, after all, provide any photographs otherwise than rather fragmentary ones, so that one or two from this specimen are probably useful.

These photographs also confirm a point already alluded to more than once, viz. that this specimen was not full grown. Comparing with the photographs in Tutt's "Brit. Lep." of Mr. Rayward's larva, it will be seen that the hair bases are still much closer together than they become in

the full-grown larva. It may also be noticed that the hair bases are very commonly surrounded by an area free from obvious skin-points, making each look like the centre of a circle.

The small size of the head for so large a larva is almost ridiculous, notwithstanding that the larva is not full grown.

The honey-gland, so conspicuous in the autumn larva, owing to its comparatively large size, remains of the same size, and looks extremely small (as compared with other Plebeiid larvae) owing to the expansion of the rest of the larva. One is inclined to regard it as still functional, the four circles seen at the bottom of the hollow being very distinct. Possibly, however, these would look just the same if the function were in abeyance, although they are certainly a feature of all functional honey-glands I have examined.

That *arion* is carnivorous in its last larval instar, not only gives us a Lycaenid of this character in the European fauna, which we were before without, though other quarters of the globe possess them, but also gives the very remarkable habit of the food being vegetable in the early stages, animal afterwards. I need not dilate on the other curious points in the life-history, but must note that the other European Lycaenines, its nearest relatives, *melanops*, *cyllarus*, *euphemus*, *arcas* and *alcon*, appear to have more or less ordinary Lycaenid habits.

The photographs presented are by Mr. A. E. Tonge.

They show—

1st. The skin of the larva found May 14, 1915 (injured in capture) × 7. It shows the difficulty of clearing away the dirt, that was one reason why the preparations from the larva given me by Mr. Rayward were not too satisfactory. It suggests that the larva did not pass its life in chambers and galleries of the ant, but amongst loose earth, etc. The comparatively small size of the head may be remarked as well as of the honey-gland; these are perhaps more noticeable in—

2nd. Portion of front of larva and of honey-gland region × 25. These three photographs may be compared with those I gave in Tutt's "Brit. Lep.," making proper allowance for different magnifications.

3rd. Portion of contents of alimentary canal forward of black mass, showing mandibles and hairs of ant larvae × 55. The preparation is not one that lends itself well to

Photo, A. E. Tonge. *Andre, Sleigh & Anglo, Ltd.*

Skin of the Larva of ***arion*** (found on May 14) × 7.